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The Peierls Transport Equation — Revised YI-KANG SHI, GREGORY EYINK, Johns Hopkins University — In 1929 Peierls derived an equation for the joint probability distribution of all wave amplitudes in classical and quantum anharmonic systems, still widely used in quantum transport theory, plasma physics and weak wave turbulence. For uncorrelated amplitudes, it implies the kinetic equation for the wave spectrum/occupation numbers. This equation was rederived by Brout & Prigogine (1956), Zaslavskii & Sagdeev (1967), and recently by Choi et al. (2005) in wave turbulence. We show that these derivations are non-systematic, retaining terms smaller than those neglected. We obtain an equation simpler than Peierls', which still implies the kinetic equation and also a generalized kinetic equation for the distribution of single-mode amplitudes, previously obtained by Choi et al. We show by an H-theorem that the single-mode distributions approach Gaussian, if this equation is valid for all amplitudes. Non-Gaussian statistics can arise if the equation breaks down for large amplitudes/strong nonlinearity. This may explain intermittency observed in laboratory experiments of weak turbulence. Moreover, we show the most general solutions of our revised Peierls equations are statistical ensembles of chaotic solutions of kinetic equations, or "super-turbulence", another source of intermittency.

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